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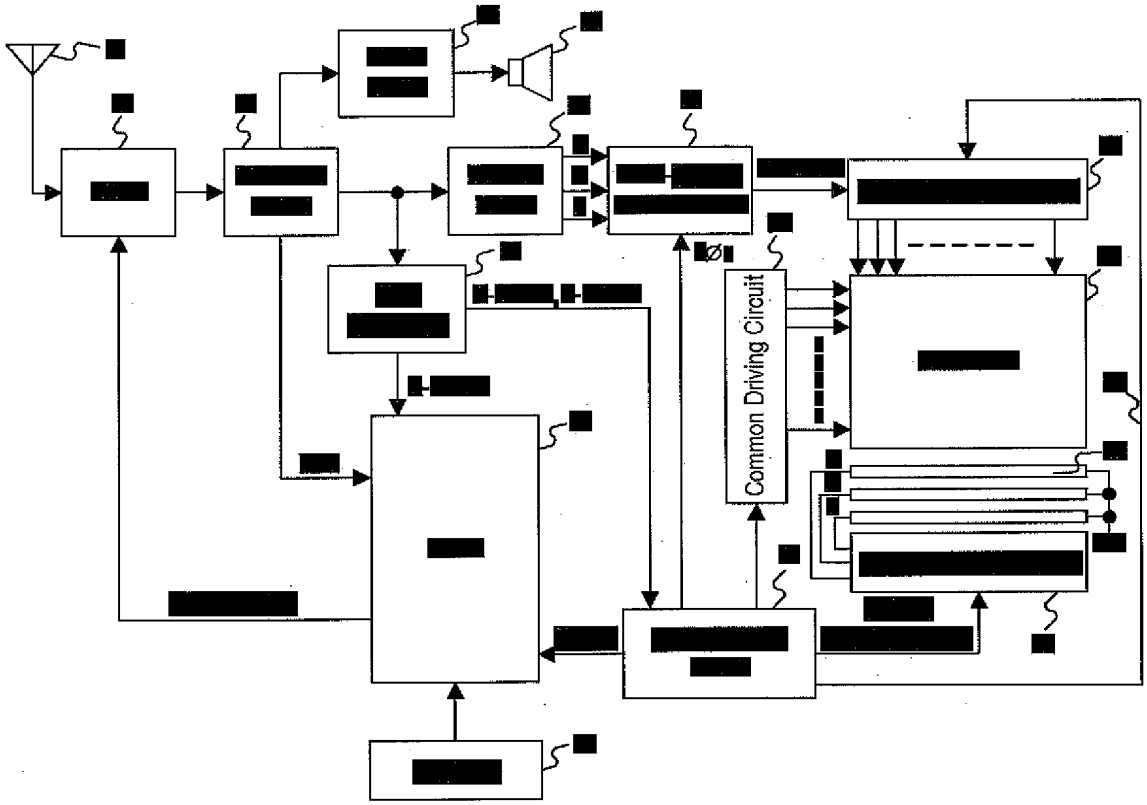
(54) [Title of the invention] Light source apparatus and color liquid crystal display apparatus

(57) [Abstract]

[Objective] To obtain a bright and high resolution screen of a backlight color liquid crystal panel.

[Structure] Three cold-cathode tubes 26 to 28 each emitting a primary color light, a pulse generation circuit 31 generating pulse signals supplied to the cold-cathode tubes 26 to 28, a switching circuit 32 switching and selecting the pulse signals generated by the pulse generation circuit 31 in a time sharing manner at a ratio in accordance with the emission properties of the emitted light colors, and light emission drivers 33 to 35 driving the cold-cathode tubes 26 to 28 based on the pulse signals supplied via the switching circuit 32 are provided.



12 tuner; 13 tuning control circuit; 14 TV linear circuit; 15 sound circuit
17 chroma circuit; 18 sync separation circuit; 19 timing control circuit
20 key input; 21 time-sharing control circuit; 22 segment driving circuit
23 common driving circuit; 24 LCD panel; 25 backlight driving circuit
13 → 12 tuning signal
19 → 25 display switching signal

[Claims]

[Claim 1] A light source apparatus characterized by comprising:
at least three fluorescent tubes each emitting a primary color light, and
a time-sharing driving means driving said fluorescent tubes for controlled light emission in a time-sharing matter at a ratio in accordance with the emission properties of the emitted light colors.

[Claim 2] A color liquid crystal display apparatus characterized by comprising:
at least three fluorescent tubes each emitting a primary color light;

a time-sharing driving means driving said fluorescent tubes for controlled light emission in a time-sharing matter at a ratio in accordance with the emission properties of the emitted light colors;
a transmissive liquid crystal panel placed in relation to said fluorescent tubes via a diffusing plate; and
an image display driving means driving said liquid crystal panel for display of a color image corresponding to the light colors emitted by said fluorescent tubes in a time-sharing manner in sync with said time-sharing driving means.
[Detailed explanation of the invention]

[0001] [Scope of the invention] The present invention relates to a light source apparatus used as a backlight in the display part of a liquid crystal television set or a personal computer and a color liquid crystal display apparatus using the light source apparatus.

[0002] [Prior art technology] Recently, color liquid crystal panel apparatuses have been extensively used in liquid crystal televisions and personal computers. The color liquid crystal panel usually comprises a transmissive liquid crystal panel integrated with a backlight source emitting white light on one side and a color filter consisting of an array of R, G, and B filters on the other. The color filter consists of R, G, and B primary color filters regularly arranged in accordance with dots on the dot matrix of the liquid crystal panel. The three primary colors (three dots) form a pixel of a displayed image. The inter-dot spaces of the color filter are light-shielded with a black mask for improved contrast.

[0003] [Problems overcome by the invention] However, the color liquid crystal panel apparatus described above has structural problems; the masked inter-dot spaces lead to low optical transmittance and, accordingly, a dark screen and the three dot formation of a pixel leads to low resolution.

[0004] The present invention is proposed in view of the above circumstances and the purpose of the present invention is to provide a light source apparatus leading to a bright and high resolution screen and a color liquid crystal display apparatus using the light source apparatus.

[0005] [Problem resolution means] The present invention utilizes at least three fluorescent tubes each emitting a primary color light and drives them for controlled light emission in a

time-sharing manner at a ratio in accordance with the emission properties of the emitted light colors.

[0006] [Effects] With the above structure, a liquid crystal panel placed in relation to the fluorescent tubes via a diffusing plate is driven for the display of a color image corresponding to the light colors emitted by the fluorescent tubes in a time-sharing manner in sync with the time-sharing light emission, so there is no need of color filters and a single dot of the liquid crystal display panel realizes a pixel for color image display. Therefore, a bright and high resolution screen can be obtained.

[0007] [Embodiment] An embodiment of the present invention in which the present invention is applied to a color liquid crystal television set is described hereafter with reference to the drawings. Fig.1 shows the entire basic circuit structure. Television electric waves are received by an antenna 11 and supplied to a tuner 12. The tuner 12 selects a specific channel according to tuning signals from a tuning control circuit 13 and transforms the electric waves into intermediate frequency signals, following which the intermediate frequency signals are transferred from the tuner 12 to a TV linear circuit 14.

[0008] The TV linear circuit 14 comprises an intermediate frequency amplifier circuit, an image detection circuit, an image amplifier circuit, and an AFT detection circuit. The intermediate frequency signals from the tuner 12 are amplified by the intermediate frequency amplifier circuit and images are detected by the image detection circuit. Sound signals are retrieved from among the signals output from the image detection circuit and supplied to a sound circuit 15.

[0009] The sound circuit 15 comprises a sound detection circuit and a sound amplifier circuit. Sound signals are detected from among signals from the TV linear circuit 14, transformed into low frequency signals, and amplified through a speaker 16.

[0010] Output signals from the image detection circuit of the TV linear circuit 14 are amplified by the image amplifier circuit and supplied to a chroma circuit17 and a sync separation circuit 18. The sync separation circuit 18 separates horizontal and vertical synchronizing signals of the image signals and supplies complex synchronizing signals C-SYNC to the tuning control circuit 13 and horizontal and vertical synchronizing signals H-SYNC and V-SYNC to a timing control circuit 19.

[0011] The AFT detection circuit of the TV liner circuit 14 detects signals output from the intermediate frequency amplifier circuit, retrieves AFT signals of which the voltage value changes in a S-letter shape, and supplies them to the tuning control circuit 13.

[0012] The tuning control circuit 13 receives key inputs such as tuning setting data and tune-up/down instructions from a key input 20. The tuning control circuit 13 generates tuning signals having a voltage value corresponding to a specific channel based on tune-up/down key operation at the key input 20 and AFT signals from the TV linear circuit 14 and supplies them to the tuner 12.

[0013] The timing control circuit 19 generates timing pulses 3ϕs based on horizontal and vertical synchronizing signals H-SYNC and V-SYNC from the sync separation circuit 18 and supplies them to a time-sharing control circuit 21.

[0014] The chroma circuit 17 performs chroma processing on image signals from the TV linear circuit 14 to obtain R, G, and B primary color signals and supplies them to the time-sharing control circuit 21. The time-sharing control circuit 21 has an un-shown A/D converter and field memory on each of the R, G, and B signal paths. Primary color signals from the chroma circuit 17 are sampled by the A/D converters in sync with the timing pulses 3ϕs into digital image data of 3 to 4-bits per pixel and stored in field memory. The primary color digital image data stored in the respective field memories are supplied to a segment driving circuit 22 in a time-sharing manner in sync with the timing pulses 3ϕs.

[0015] The timing control circuit 19 generates display control timing signals based on horizontal and vertical synchronizing signals H-SYNC and V-SYNC from the TV liner circuit 14 to control the operations of the segment driving circuit 22 and a common driving circuit 23.

[0016] The common driving circuit 23 generates scan signals according to timing signals from the timing control circuit 19 and sequentially drives the common electrodes of a monoclonal display transmissive LCD panel 24. The segment driving circuit 22 sequentially reads 3 to 4-bit image data from the time-sharing control circuit 21 according to the timing signals from the timing control circuit 19. Each time image data for one line is read, the segment driving circuit 22 generates gray-scale signals according to the image data and drives the segment electrodes of the LCD panel 24 for display.

[0017] The timing control circuit 19 supplies display switching signals to a backlight driving circuit 25 in sync with the time-sharing timing by the time-sharing control circuit 21. The backlight driving circuit 25 drives cold-cathode tubes 26 to 28 serving as a backlight source of the LCD panel 24 and each emitting a R, G, or B primary color light for light emission in a time-sharing manner according to display switching signals from the timing control circuit 19. Light emitted by the cold-cathode tubes 26 to 28 illuminates the LCD panel 24 from the back as a sheet of uniform light via an un-shown diffusing plate.

[0018] A specific structure of the backlight driving circuit 25 and cold-cathode tubes 26 to 28 is described hereafter. Fig.2 primarily shows the circuit structure of the backlight driving circuit 25. A backlight-on signal is supplied from an un-shown control circuit to a pulse generation circuit 31. The pulse generation circuit 31 generates pulse signals having a sufficiently high frequency compared to color image switching frequencies, which are for example 180 Hz, based on the backlight-on signal.

[0019] The pulse signals generated by the pulse signal generation circuit 31 are switched and selected by the switching circuit 32 according to display switching signals from the timing control circuit 19 and supplied to one of R light emission driver 33, G light emission driver 34, and B light emission driver 35 in a time-sharing manner.

[0020] The R light emission driver 33, G light emission driver 34, and B light emission driver 35 amplify and boost pulse signals supplied via the switching circuit 32 to turn on the cold-cathode tubes (fluorescent tubes) 26 to 28. The cold-cathode tubes 26 to 28 each have a fluorescent coating on the tube inner surface and emit an R, G, or B primary color light when turned on by the light emission drivers 33 to 35.

[0021] Fig.3 shows a representative inner circuit structure of the R light emission driver 33 (G light emission driver 34 and B light emission driver 35). The structure is similar to that of a general cathode tube driving circuit and, therefore, briefly described. In the figure, pulse signals supplied via the switching circuit 32 are amplified by an amplifier circuit consisting of resistors R1 to R5, a PNP transistor Tr1, an NPN transistor Tr2, and a power FET using a direct backup power source $+V_B$ and applied to the electrodes of the primary coil of a booster transformer 41 additionally provided with a capacitor C1 and a diode D1 for protection against back electromotive force. Connected to the secondary coil

of the booster transformer 41, a voltage boosted by the booster transformer 41 is applied to the cold-cathode tube 26 (to 28) to emit light.

[0022] With the above structure, R (red) image data for one screen image stored in the time-sharing control circuit 21 are sequentially read into the segment driving circuit 22 and displayed on the LCD panel 24 for a display time T_R in Fig.4 (1). In sync with this, the switching circuit 32 of the backlight drive circuit 25 supplies pulse signals generated by the pulse generation circuit 31 to the R light emission driver 33 for a time period I in Fig.4 (2) in response to the display switching signal from the timing control circuit 19, turning on the cold-cathode tube 26 to emit red light. Consequently, with the cold-cathode 26 as a backlight emitting red light via a diffusing plate, a red image is displayed although the LCD panel 24 itself is a monoclonal structure.

[0023] When the reading of the R (red) image data from the time-sharing control circuit 21 is completed, G (green) image data are sequentially read into the segment driving circuit 22 and displayed on the LCD panel 24 for a display time T_G in Fig.4 (1). In sync with this, the switching circuit 32 of the backlight drive circuit 25 supplies pulse signals generated by the pulse generation circuit 31 to the G light emission driver 34 for a time period II in Fig.4 (2) in response to the display switching signal from the timing control circuit 19, turning on the cold-cathode tube 27 to emit green light. Consequently, with the cold-cathode 27 as a backlight emitting green light via a diffusing plate, a green image is displayed although the LCD panel 24 itself is a monoclonal structure.

[0024] Similarly, when the reading of the G (green) image data from the time-sharing control circuit 21 is completed, B (blue) image data are sequentially read into the segment driving circuit 22 and displayed on the LCD panel 24 for a display time T_B in Fig.4 (1). In sync with this, the switching circuit 32 of the backlight drive circuit 25 supplies pulse signals generated by the pulse generation circuit 31 to the B light emission driver 35 for a time period III in Fig.4 (2) in response to the display switching signal from the timing control circuit 19, turning on the cold-cathode tube 28 to emit blue light. Consequently, with the cold-cathode 28 as a backlight emitting blue light via a diffusing plate, a blue image is displayed although the LCD panel 24 itself is a monoclonal structure.

[0025] The primary color image display times T_R, T_G, and T_B are separated by a display idle time. The display idle time lasts for a blanking time BL plus a writing time WR for the primary color image data read from the time-sharing control circuit 21 to be written in

the segment driving circuit 22.

[0026] The cold-cathode tubes 26 to 28 have decay characteristics of different durations. The display driving times of the cold-cathode tubes 26 to 28 as indicated by the above I to III are shorter than the image display times T_R, T_G, and T_B. In Fig.4 (2), the ratio I : II : III is 3 : 2 : 4. However, any ratio can be pre-selected while considering the decay characteristics of the cold-cathode tubes 26 to 28 in use. In addition, the light emission of the cold-cathode tubes 26 to 28 can be started slightly earlier because of the time-lag between the initiation of light emission and the actual emission.

[0027] As described above, three, R, G, and B, different image data are displayed in 1/60 to 1/50 second in a time-sharing manner to display a color screen image. Here, a single display dot on the LCD panel 24 can realize a pixel for color display. In this embodiment, the fluorescent tubes are cold-cathode tubes. Needless to say, hot-cathode tubes can similarly be used.

[0028] [Efficacy of the invention] With the present invention described above, there is no need of color filters and a single dot on the liquid crystal panel realizes a pixel for color image display, thereby providing a light source apparatus leading to a bright and high resolution screen and a color liquid crystal display apparatus using the light source apparatus.

[Brief explanation of the drawings]

[Fig.1] A block diagram showing the circuit structure of a color liquid crystal television set according to an embodiment of the present invention.

[Fig.2] A block diagram primarily showing the internal structure of the backlight driving circuit in Fig.1.

[Fig.3] An illustration showing the circuit structure within a light emission driver in Fig.2.

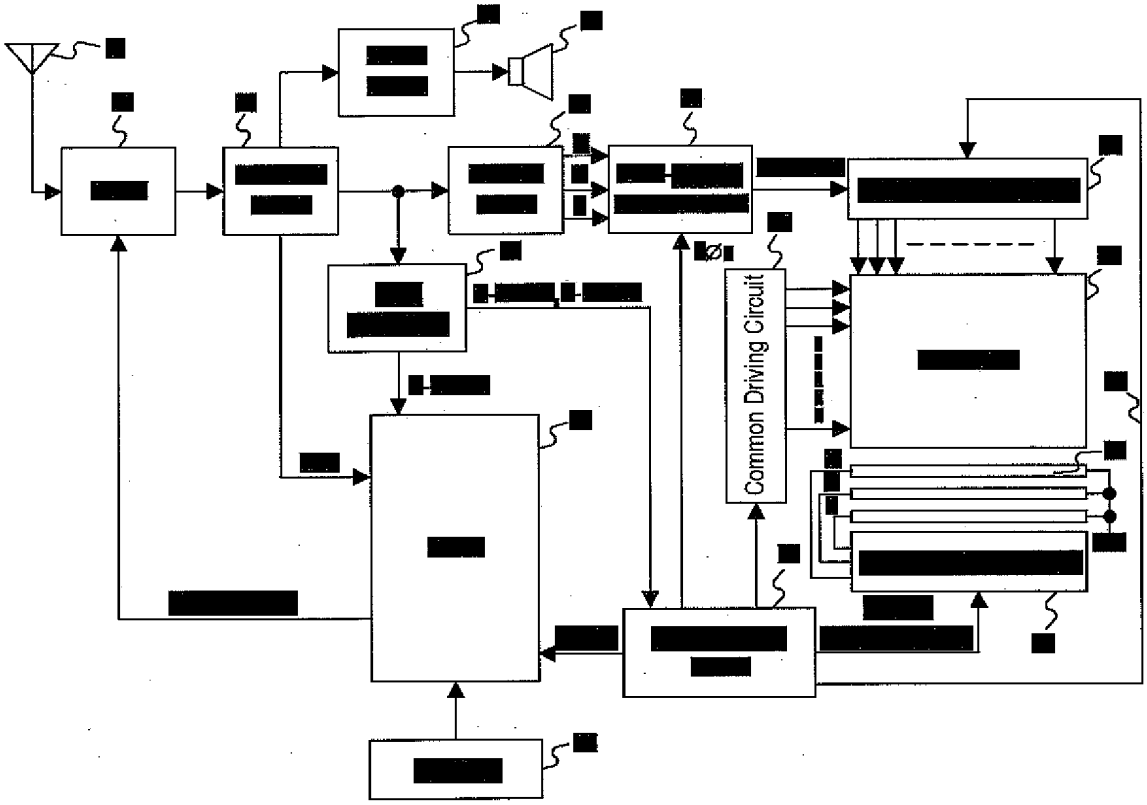
[Fig.4] An illustration for explaining the operation according to the embodiment.

[Legend]

11 ... antenna, 12 ... tuner, 13 ... tuning control circuit, 14 ... TV linear circuit, 15 ... sound

circuit, 16 ... speaker, 17 ... chroma circuit, 18 ... sync separation circuit, 19 ... timing control circuit, 20 ... key input, 21 ... time-sharing control circuit, 22 ... segment driving circuit, 23 ... common driving circuit, 24 ... LCD panel, 25 ... backlight driving circuit, 26 to 28 ... cold-cathode tube, 31 ... pulse generation circuit, 32 ... switching circuit, 33 ... R light emission driver, 34 ... G light emission driver, 35 ... B light emission driver.

[Fig.1]



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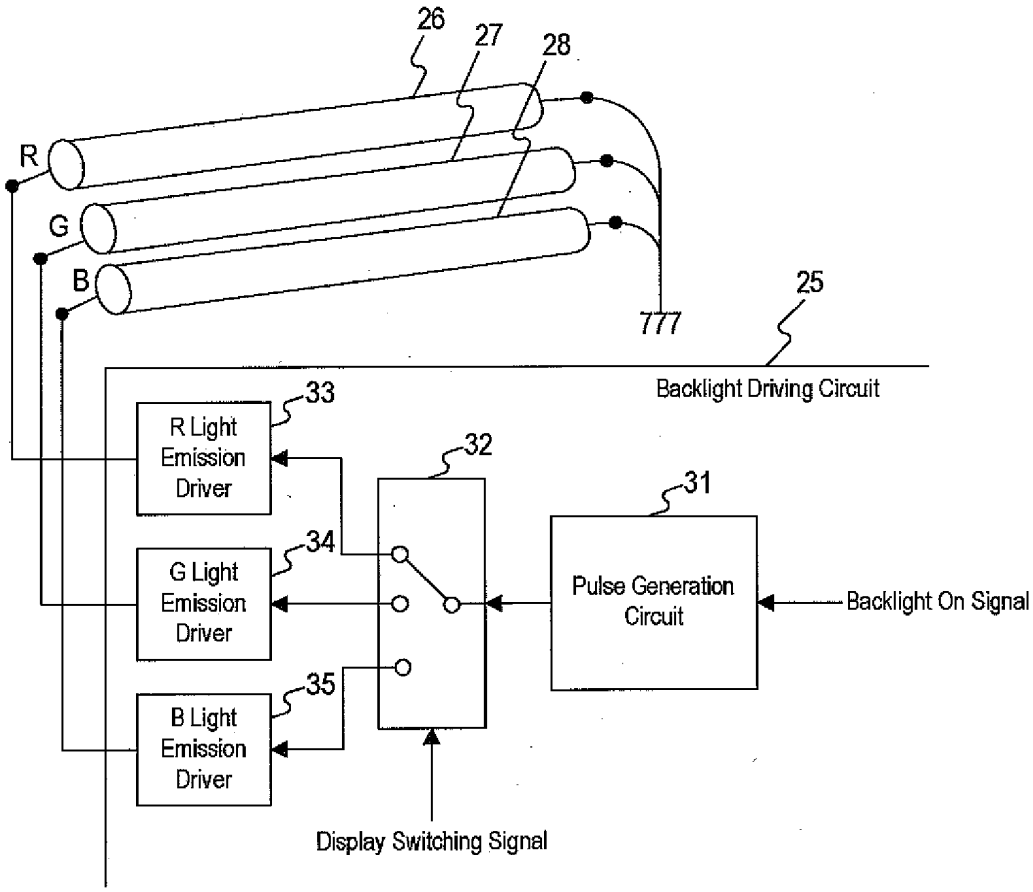
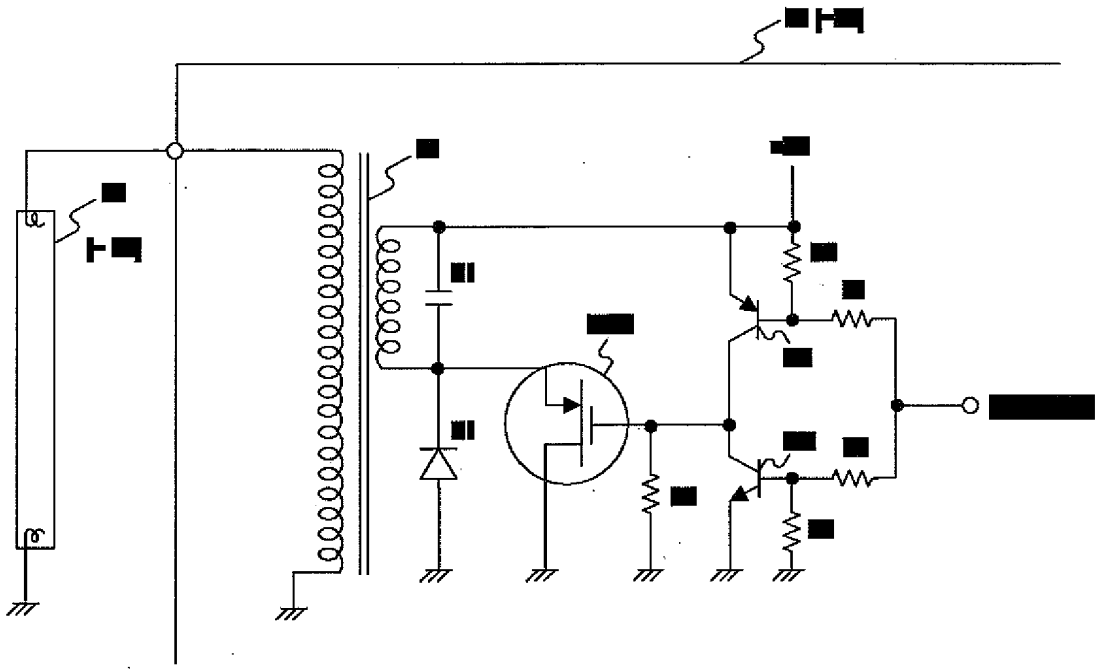
20 key input; 21 time-sharing control circuit; 22 segment driving circuit;
23 common driving circuit; 24 LCD panel; 25 backlight driving circuit;
13 → 12 tuning signal
19 → 25 display switching signal

[Fig.2]

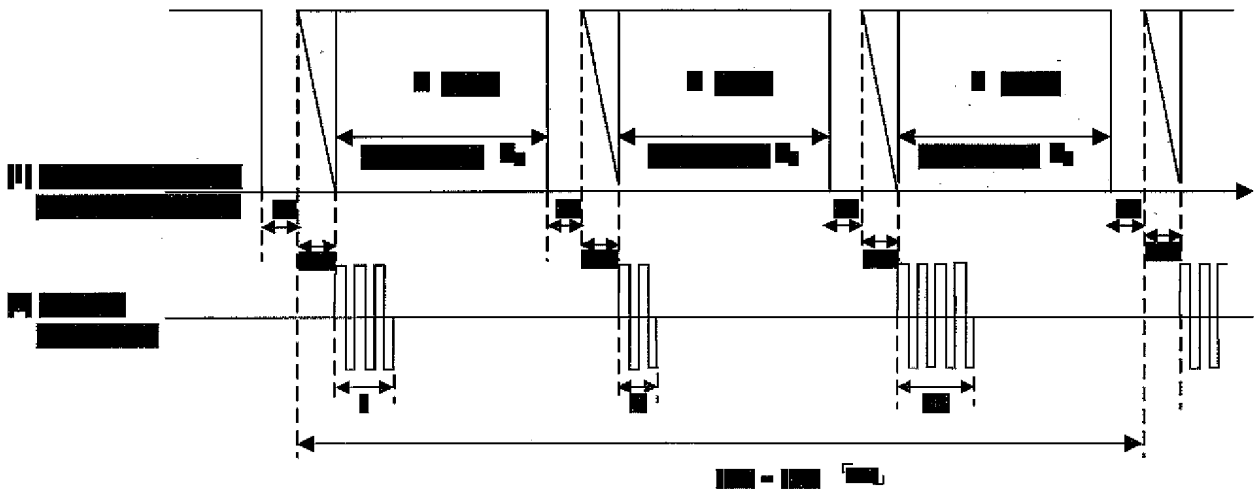


25 backlight driving circuit; 31 pulse generation circuit; 33 R light emission driver; 34 G light emission driver; 35B light emission driver; display switching signal → 32 backlight-on signal → 31

[Fig.3]



[Fig.4]



R image, display time T_R ; G image, display time T_G ; B image, display time T_B

(1) liquid crystal display timing

blanking time

(2) backlight display time

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B32B	7/12	
	27/12	
	27/40	
	31/12	
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	105:04	
B29L	9:00	
	31:58	
G02F	1/133	535
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G09G	3/36	

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B29C	65/52	
B32B	7/12	
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G09G	3/36	

[Amendment]
[Filing date] November 13, 2000
[Amendment 1]
[Document for amendment] Specification
[Object for amendment] Claims
[Amendment method] Change
[Contents of amendment]
[Claims]
[Claim 1] A light source apparatus characterized by comprising:
at least three fluorescent tubes each emitting a color light different from each other; and

a time-sharing driving means driving said fluorescent tubes for controlled light emission in a time-sharing matter at a ratio in accordance with the emission properties of the emitted light colors.

[Claim 2] A color liquid crystal display apparatus characterized by comprising:

at least three fluorescent tubes each emitting a color light different from each other;

a time-sharing driving means driving said fluorescent tubes for controlled light emission in a time-sharing matter at a ratio in accordance with the emission properties of the emitted light colors;

a transmissive liquid crystal panel placed in relation to said fluorescent tubes via a diffusing plate; and

an image display driving means driving said liquid crystal panel for display of image data corresponding to the light colors emitted by said fluorescent tubes in a time-sharing manner in sync with said time-sharing driving means.

[Amendment 2]

[Document for amendment] Specification

[Object for amendment] 0005

[Amendment method] Change

[Contents of amendment]

[Problem resolution means] The present invention utilizes at least three fluorescent tubes each emitting a color light different from each other and drive them for controlled light emission in a time-sharing manner at a ratio in accordance with the emission properties of the emitted light colors.

CERTIFICATE OF TRANSLATION

I Roger P. Lewis, whose address is 42 Bird Street North, Martinsburg WV 25401, declare and state the following:

I am well acquainted with the English and Japanese languages and have in the past translated numerous English/Japanese documents of legal and/or technical content.

I hereby certify that the Japanese translation of the attached translation of documents identified as

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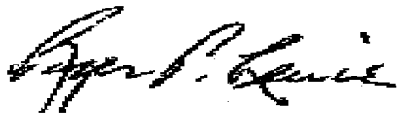
" Light source apparatus and color liquid crystal display apparatus"

is to the best of my knowledge and ability true and accurate.

I further declare that all statements contained herein of our own knowledge, are true, that all statements of information and belief are believed to be true.



ROGER P. LEWIS

January 9, 2007